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required for mounting, since in the cooler described above, after the heat-receiving header and the radiating header have been mounted, the flexible tubes must be placed on the wiring substrate.

(3) Moreover, the parts composing the cooler is separately distributed therewithin, making it difficult to cut down on the space in a notebook personal computer or the like. This prevents the notebook personal computer or the like from being downsized and made thinner.

As described above, no cooler has yet been provided which fulfills the following requirements for a smaller size or thinner type of electronic device like a notebook personal computer, i.e., the cooler must be smaller and thinner, the cooler must have an effective and sufficient effect for heat-radiation, and the cooler can safely be used in such an electronic device.

SUMMARY OF THE INVENTION

The present invention has been made to solve the technical problems described above, and an object of the present invention is to provide a cooler for an electronic device which is smaller and thinner than the conventional cooler, which can show a sufficient cooling effect with higher effectiveness, and which has no risk of being damaged.

As described in Claim 1, the cooler for an electronic device according to the present invention which has been made to attain the object described above is a cooler for an electronic device which forcibly cools a heating element provided on the electronic device by circulating a cooling liquid, which comprises: a liquid cooling mechanism composed of a substrate, a heat sink formed on said substrate in a flat shape having a heat-receiving face at one surface thereof intended to be in contact with said heating element and having a liquid channel formed therein, a pump portion having a

housing formed in a flat shape on said substrate, and an impeller rotatably formed in said housing to circulate said cooling liquid, metal pipes connected to said pump portion and said liquid channel of the heat sink through which metal pipes said cooling liquid is circulated; and a forcible air cooling mechanism composed of a radiating fin provided on the outer surface of said metal pipes, and a fan which cools said radiating fin and said housing, said pump portion of the liquid cooling mechanism and said fan of the forcible air cooling mechanism being provided on said substrate in a vertically aligned positional relationship such that said liquid cooling mechanism and said air cooling mechanism are unified with each other.

Due to such a construction, since the heat sink is formed into a flat shape, the heat-receiving face can be enlarged and, thus, the heat generated in the electronic device is transmitted to the liquid channel via the heat-receiving face having such an enlarged area, making it possible to maintain the temperature of the electronic device within the tolerance level. On the other hand, since the cooling liquid heated due to the heat exchange is forcibly cooled by means of the forcible air cooling mechanism, the cooler can maintain a large cooling effect, even if the electronic device is used over a prolonged period of time. The higher the cooling effect of the cooler, the easier the downsizing of the cooler becomes.

Since the pipe portion and the liquid channel of the heat sink are connected by means of the metal pipes, there is no risk of leakage of damaging the electronic device itself. What is more, the cooler of the present invention is unified into a whole unit and is made into a fixed form by connecting the pump portion and the heat sink by means of the metal pipes. Consequently, in contrast to the conventional cooler, it is not required to place flexible tubes on the

wiring substrate, so it becomes easy to mount the cooler. Moreover, the pump can be continuously driven, making it possible to continuously and effectively cool the cooling liquid. Further, it is possible to unify the liquid cooling mechanism and the forcible air cooling system because the pump portion of the liquid cooling mechanism and the fan of the forcible air cooling mechanism are provided in a vertically aligned positional relationship such that the unified and unitized whole structure is easily mounted onto the electronic device. Moreover, it is possible to cool the pump portion itself because the pump portion of the liquid cooling mechanism and the fan of the forcible air cooling mechanism are provided in a vertically aligned positional relationship.

It is desirable for the cooler of the present invention to arrange the impeller and the fan therewihin such that the axis of

the pump portion 13.

As shown in Fig. 6, the rotation mechanism for rotating the impeller 16 of the pump portion 3 may also have a construction such that a magnet 38 for driving the impeller 16 is fixed on the lower surface of the fan 25, and the passive magnet 39 which is subjected to the magnetic force of the magnet 38 for driving the impeller 16 is embedded on the upper surface of the impeller 16.

By having such a construction, when the fan 25 is rotated under the effect of the magnetic fluctuation of the coils 35 of the motor substrate 33, the impeller 16 having the passive magnet 39, which is subjected to the magnetic force of the magnet 38 for driving the impeller placed on the fan 25 and the passive magnet 39 placed on the impeller 16, it is possible to construct a driving mechanism for driving the impeller 16.

Since the driving mechanism for driving the impeller 16 shown in Fig. 3 omits the magnet 38 for driving the impeller, only the two magnets are required to be used for the magnet 29 for driving the fan. This mechanism has a construction simpler than that of the driving mechanism for driving the impeller 16 shown in Fig. 6.

Furthermore, in any case of the driving mechanism for driving the impeller 16 shown in Fig. 3 or Fig. 6, since the motor substrate 33 composed of an insulating substrate in a plate form, the fan 25 formed in a thin plate and the pump portion 3 formed in a flat shape are laminated on each other in a vertically aligned positional relationship such that the pump portion 3 of the liquid cooling mechanism B and the forcible air cooling mechanism C are downsized in a compact and thinner size. Furthermore, since the pump portion of the liquid cooling mechanism and the fan of the forcible air cooling mechanism are provided in a vertically aligned

positional relationship on said substrate, it is possible to unify said liquid cooling mechanism and said forcible air cooling mechanism such that the unitized whole structure is easily mounted onto the electronic device. Furthermore, it is possible to cool the pump portion itself because the pump portion of the liquid cooling mechanism and the fan of the forcible air cooling mechanism are provided in a vertically aligned positional relationship.

Furthermore, since at least part of the heat-radiation fin 37, and metal pipes 20 and 21, surrounding the outside of the pump portion 3 is placed facing the port 24 such that it can directly come